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Research Article

Optimal Portfolio Analysis of Cross-Sector Stocks on the Indonesia Stock Exchange (IDX)

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Abstract: This study applies the Mean Variance model, which aims to form an optimal portfolio composition in the health, property, and cyclical consumer sectors and combine the three sectors into one portfolio, then visualize its efficient frontier. This study analyzes the return profiles and compares the risks of each portfolio using alternative risk measures such as the Coefficient of Variation (CV), Value at Risk (VaR), and Conditional Value at Risk (CVaR). Daily closing price data for the three sectors listed on the Indonesia Stock Exchange (IDX) from March 2, 2020, to March 3, 2025, were used in this study. Stock selection was conducted using purposive sampling, followed by selecting seven stocks for optimization based on the lowest Coefficient of Variation (CV) value. Portfolio optimization analysis was conducted using the Python programming language with Visual Studio Code software. The findings of this study indicate that the combined portfolio incorporating the three sectors is the most efficient, with an expected return of 0.104%, standard deviation of 0.007, and alternative risk measures such as Coefficient of Variation (CV) 6.9328, Value at Risk (VaR) of -0.99%, and Conditional Value at Risk (CVaR) of -1.44%, which are lower than those of single-sector portfolios. Visualization of the efficient frontier curve confirms that the combined portfolio offers better results in terms of risk and return. The results of this study indicate that cross-sector diversification can significantly reduce risk and prevent significant losses.

Keywords: CV; CVaR; Mean-Variance; Optimal Portfolio; VaR

1. Introduction

Investment is the allocation of funds to assets with the expectation of generating a profit. Stocks are one type of asset. Stocks are securities or proof of ownership in a company. These assets are traded to generate returns. Stock investment always involves risk, namely the possibility that returns may not meet expectations. Among the many factors influencing risk, macroeconomic conditions are one of them, reflected through volatility in the Composite Stock Price Index (IHSG) (Rindika, 2024). In recent years, Indonesia has experienced macroeconomic events caused by the spread of the virus in early 2020.

In late 2019, Coronavirus Disease 19 (COVID-19) was first detected at the Huanan Seafood Wholesale Market in Wuhan City, Hubei Province, China, with several residents exhibiting symptoms related to COVID-19 simultaneously. By January 30, 2020, a total of 9,976 cases had been reported in 21 countries (Holshue et al., 2020). Indonesia was no exception. On March 2, 2020, the government officially announced the first COVID-19 case, which occurred in Depok, West Java Province, involving a 61-year-old mother and her 31-year-old daughter (Kompas.com, 2022). This case caused high volatility in the stock market, with the Composite Stock Price Index (*Indeks Harga Saham Gabungan* or IHSG) declining in the second week of March 2020 to 4,907.57, from 5,498.54, and continuing to fluctuate throughout the pandemic (Tambunan, 2020).

Issuers listed on the IHSG showed varied reactions since the announcement of the first case. Rosman & Yudanto (2022) in their research found that each sector had a different response to the announcement of the first COVID-19 case. Cyclical consumer and property sectors were the most affected, as indicated by a decline in abnormal returns. The health sector was the most benefited, with the highest abnormal return increase among other sectors.

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Abnormal returns are the difference between actual returns and expected returns. Expected returns are the rate of return that investors expect (Anisa et al., 2020). The escalation in demand for healthcare products during the pandemic played a role in improving the financial performance of healthcare companies, particularly in terms of profitability ratios (Victoria et al., 2025).

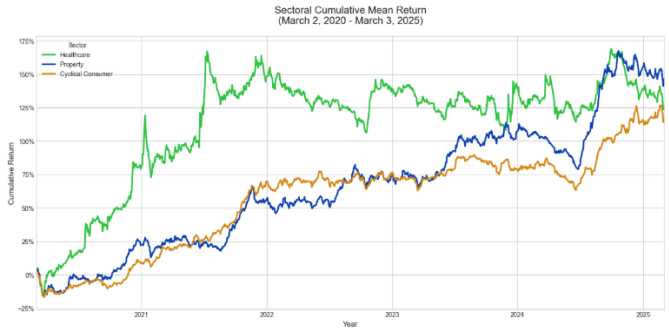

Figure 1. Sectoral Cumulative Mean Return (March 2, 2020 – March 3, 2025)
Source: Yahoo Finance, processed by the author, 2025

The Indonesian government began its COVID-19 vaccination program on January 13, 2021, and the IHSG performance strengthened again by 44.27 points or 0.69% to 6,439.93 (Atmoko, 2021). Tanjung et al., 2022, stated that the national vaccination program was a factor in stabilizing the Indonesian stock market during the pandemic. Since the vaccination program began, the pace of recovery in returns across various sectors has varied. Visualization based on cumulative average returns illustrates the differences in sector performance. The healthcare sector experienced a correction after seeing returns surge by more than 150% at the beginning of the period, with returns tending to move sideways until the end of the period. The property sector (blue line) showed the most progressive performance and a strong recovery trend, reaching the highest cumulative figure at the end of the period. The cyclical consumer sector (orange line) also recorded consistent growth, with a more stable trajectory.

The differences in performance between the three sectors were influenced by several factors. During the vaccination program until 2025, the government has formulated various domestic policies aimed at restoring the economy, which have influenced the differences in performance between sectors, such as interest rate adjustments, fiscal incentives including Government-Borne Value Added Tax (*Pajak Pertambahan Nilai Ditanggung Pemerintah* or PPN DTP), and changes in social class, which have contributed to shifts in household consumption patterns. These dynamics have caused shifts in the risk and return profiles of each sector, requiring comprehensive investment strategies to achieve an efficient or optimal portfolio.

Modern Portfolio Theory (MPT), a framework introduced by Harry Max Markowitz. Markowitz (1952) states that investors ideally want high returns (Expected Return) but dislike risk (Variance). Based on this statement, a portfolio is considered optimal if it offers the highest return for a certain level of risk, or the lowest risk for a certain level of return. Diversification is a way to achieve an optimal portfolio by combining stocks that do not have high covariance with each other. The reason is that companies in the same sector tend to perform poorly at the same time, so they have high correlation and covariance. The implementation of this framework becomes more complex as the number of stocks to be optimized increases.

The application of this framework in research in Indonesia has been quite extensive. For example, Rusmiati et al. (2022) examined its application to the IDX30 index. Arifin & Mutasowifin (2022) studied this framework in relation to the IDX80 index. Anam et al. (2021) applied it to sharia stocks in the Jakarta Islamic Index (JII). Prawatiningsih (2021) used this framework to test portfolio rebalancing across nine sectors listed on the Indonesia Stock Exchange (IDX) compared to no rebalancing, but did not compare the effectiveness of rebalancing across each sector. Aminda (2019) also studied the optimal combination for nine sectors with fifty samples, but did not provide a graphical representation of the efficient frontier. The previous studies mentioned provide a strong foundation, but they only focus on specific indices and do not compare the performance of sectors that react differently to macroeconomic events.

This study aims to analyze the optimal composition of the health, property, and cyclical consumer sectors, as well as the composition when these three sectors are combined. The first specific objective of this study is to form an optimal portfolio for each sector separately and for the combined portfolio. The second specific objective is to visualize the efficient

frontier graph for each sector and the combination of the three sectors. The third specific objective is to compare the expected return profiles and alternative risk measures of the portfolios for each sector and the combined portfolio of the three sectors. This study is expected to provide insights for investors or readers considering stock investments.

2. Literature Review

Mean Variance

Mean Variance is a concept that underlies Modern Portfolio Theory (MPT). This concept considers two main factors, namely Expected Return (Mean) and Risk or Volatility (Variance/Standard Deviation). Expected Return (Mean) is the profit expected by investors when investing in a stock, calculated by summing the weights of the securities multiplied by the expected returns of each security. Risk (Variance/Standard Deviation) is the risk that investors do not want when investing, calculated from the sum of weighted covariances (Gültekin et al., 2020). Investors tend to choose portfolios that offer an efficient combination of Expected Return and Variance of Return (E-V), portfolios that offer minimum variance for a certain level of expected return, or maximum expected return with lower variance (Balqis et al., 2021).

To achieve an efficient E-V, Markowitz (1952) implied the need for diversification, namely, spreading funds across various stocks with negative correlations, so that the price movements of one stock tend not to follow the price movements of others, such as selecting stocks in different industries. Dai (2023) research uses the Mean Variance model to create an optimal portfolio consisting of major stocks in the technology, financial services, and consumer goods industries in the United States. The study supports the idea that diversification can manage returns and risks more effectively. Cross-sector diversification is also effective in reducing portfolio risk, including total risk, non-systematic risk, and systematic risk, while considering investors' risk preferences, such as risk-averse investors and risk-tolerant investors (Yaman & Tuncel, 2025). Combining a portfolio containing stocks from different industries into a single portfolio is also recommended, as when one stock performs poorly, other stocks from different industries may perform well or at least not too poorly, thereby minimizing the overall variance of the portfolio (James et al., 2022).

Efficient Frontier

Harry Max Markowitz developed a geometric representation to help investors identify optimal portfolios based on the concept of Mean Variance. This representation is known as the Efficient Frontier Curve, which is a set of portfolios that offer maximum expected return for a given variance or minimum variance for a given expected return. There are two main components in this curve: expected return on the vertical axis (Y) and variance on the horizontal axis (X). The Y-axis represents the return expected by investors when investing, and the X-axis represents the risk accepted by investors when seeking to increase the expected return (Guo, 2022)

This curve curves upward and to the right; the higher the expected return, the greater the risk, or the further to the right. Each curve represents a portfolio of stocks selected by investors. Along this curve are points representing each E-V pair from the calculation of expected return and variance based on the weight allocation selected by investors for each stock.

The efficient frontier provides an overview of the risk-return trade-off between two stock markets in different countries. A study by Waluyo et al. (2024) constructed an efficient frontier for the top five stocks in the Malaysian and Indonesian stock markets, as well as a combined frontier for both markets. The Malaysian stock portfolio offers lower returns and higher risk compared to the Indonesian stock portfolio, while the efficient frontier of the combined portfolio yields more optimal results than the separate portfolios. Research by He (2024), which compares portfolios with maximum Sharpe ratio and minimum variance in the Chinese stock market, shows that the efficient frontier can provide guidance for investors in making investment decisions based on their preferences.

Assumptions in the Mean Variance Model

Modern Portfolio Theory (MPT) is based on assumptions about investor behavior and market conditions. Investors always act rationally and avoid risk, making decisions based on two factors, expected return as the desired outcome and variance as the undesired outcome (Martínez-Nieto et al., 2021). As explained earlier, investors will choose a portfolio that provides minimum variance for a given level of return, or maximum return for a given level of variance according to the E-V rule.

According to Fama (1965), the Mean Variance model assumes that investors act based on their probabilistic beliefs about expected return and variance performance. The model's scope focuses solely on portfolio selection after beliefs about future stock performance have been formed. Fama (1965) revealed that in this model, stock returns are considered to be normally distributed and bound to variance as a measure of risk that disregards market realities. The practical dimension of this market reality, called the intrinsic value of a company, changes significantly and rapidly as a result of uncertain and unpredictable market information processes. Rapid changes in intrinsic value cause discontinuous price jumps, which ultimately lead to a long-tail distribution. Markowitz (1952) built on this assumption to simplify complex portfolio analysis into a mathematical optimization problem that could be solved.

Risk Measures in Modern Portfolio Theory (MPT)

Standard deviation, although a classic measure of risk in the Mean Variance model, does not adequately describe the overall risk profile, particularly for extreme loss potential (Kipp & Koziol, 2022). A more comprehensive metric is needed for performance evaluation and risk analysis than standard deviation. Modern researchers no longer rely on standard deviation to measure the risk of portfolios created by the Mean Variance model. Quantitative theoretical research by Alexander & Baptista (2004) compared the risk measures Value at Risk (VaR) and Conditional Value at Risk (CVaR). VaR is defined as the estimated maximum loss occurring at a certain probability or significance level (5%) and confidence level (typically 95%) over an investment period. Conversely, CVaR is the maximum loss that occurs at a certain confidence level over an investment period, assuming that the loss is equal to or greater than its VaR. The research findings reveal that CVaR is fundamentally more coherent and more effective in controlling portfolio risk, especially for risk-averse investors.

CVaR offers advantages over VaR, as demonstrated by Mulvey & Erkan (2006) in their study focusing on companies across various sectors in the global financial industry. The results show that CVaR provides a consistent and flexible risk measure due to its sub-additivity property, meaning that the combined risk of a portfolio will not exceed the sum of the risks of its individual components. Lin & Ohnishi (2007) also demonstrated similar findings, showing that CVaR is a stronger and more flexible risk measure, especially in complex financial markets that are not always normally distributed, unlike VaR, which is only coherent if normally distributed. They studied 28 types of industry indices on the Tokyo Stock Exchange (TSE).

VaR and CVaR have become alternative risk metrics, in addition to standard deviation. In their development, VaR and CVaR are calculated using several methods. Methodological literature shows that measurement results are highly dependent on the estimation method used. Practical theoretical research by Abad et al. (2014) reveals that there are several calculation methods, namely parametric, non-parametric, and semi-parametric. Parametric and non-parametric methods are easy to implement. The difference between the two is that parametric methods rely on the assumption of normal distribution, thereby ignoring long-tail distributions, while non-parametric methods do not depend on the assumption of normal distribution. Semi-parametric methods are superior because they combine parametric and non-parametric methods, but they are difficult to implement due to their complexity and require considerable computational costs. A survey conducted by Perignon & Smith (2009) of 60 American, Canadian, and international banks between 1996 and 2005 found that 73% of these banks used the non-parametric historical simulation method. The historical simulation method uses empirical distributions of past returns to generate VaR values and does not assume a normal distribution. Because it does not use assumptions, historical simulation is better at modeling fat tails (Sharma, 2012).

Another metric besides VaR and CVaR is the Coefficient of Variation (CV), which is the ratio of standard deviation to expected return. The lower the CV value, the lower the stock's risk. According to Campeciño (2022), CV is a direct measure of risk, unlike the MPT, which uses volatility (Variance/Standard Deviation) as a measure of risk. The results of Campeciño (2022) study on 3,000 domestic US stocks found that stocks with low but positive CV values showed exponential growth. He also used this metric to select stocks for building an optimal portfolio.

3. Research Method

This study uses a quantitative descriptive method. The data used in this study, which comes from the daily closing prices of stocks in the health, property, and cyclical consumer sectors listed on the Indonesia Stock Exchange (IDX) from the Yahoo Finance website, covers the period from March 2, 2020, to March 3, 2025, and is used in this study. Purposive sampling was used to determine the sample according to the established criteria. Purposive sampling is a technique for selecting targets that have relevant characteristics in accordance with the specific objectives of the research to be explored and studied (Turner, 2020).

There are two criteria in this study, exclusion of companies with incomplete daily closing price data for the specified period and companies that have been placed under special monitoring on the stock exchange listing board. Special monitoring status is assigned to companies that are considered to have high financial, operational, and liquidity risks in order to provide transparency and protection to investors (Bursa Efek Indonesia, 2023). The purpose of establishing the aforementioned criteria is to ensure that the calculation results are unbiased.

In this study, the Python programming language was used to optimize stock portfolios, with Visual Studio Code as the code editor. Python has several third-party libraries created to support user activities. The libraries used are, first, yfinance, for automatically downloading the closing prices of stocks from all three sectors at once, second, pandas, for manipulating and analyzing data, third, NumPy, for performing mathematical calculations; fourth, SciPy.optimize, for the optimization process to find the best portfolio, and fifth, Matplotlib.pyplot, which visualizes the efficient frontier graph.

Table 1. Sample and Population

Criteria	Amount
Healthcare companies listed on the Indonesia Stock Exchange (IDX) for the period March 2, 2020 - March 3, 2025	36
Property sector companies listed on the Indonesia Stock Exchange (IDX) for the period March 2, 2020 - March 3, 2025	94
Cyclical consumer sector companies listed on the Indonesia Stock Exchange (IDX) for the period March 2, 2020 - March 3, 2025	166
Total Population	**296**
Healthcare companies that have been placed under special monitoring	(2)
Property sector companies that have been placed under special monitoring	(28)
Cyclical consumer sector companies that have been placed under special monitoring	(38)
Total	**228**
Healthcare sector companies with incomplete daily closing price data	(18)
Property sector companies with incomplete daily closing price data	(23)
Cyclical consumer sector companies with incomplete daily closing price data	(54)
Sample	**133**

The samples obtained are first calculated using the Coefficient of Variance (CV), after which the Coefficient of Variation (CV) value is used as a reference for stock selection, with stocks with lower CVs being prioritized as candidates for the portfolio. The seven stocks with the lowest CV values in each sector are selected for optimization.

The healthcare sector consists of PT Siloam International Hospitals Tbk (SILO), PT Sejahteraraya Anugrahjaya Tbk (SRAJ), PT Tempo Scan Pacific Tbk (TSPC), PT Pyridam Farma Tbk (PYFA), PT Sarana Meditama Metropolitan Tbk (SAME), PT Merck Tbk (MERK), PT Medikaloka Hermina Tbk (HEAL). The property sector consists of PT Pantai Indah Kapuk Dua Tbk (PANI), PT Suryamas Dutamakmur Tbk (SMDM), PT Star Pacific Tbk (LPLI), PT Kota Satu Properti Tbk (SATU), PT Roda Vivatex Tbk (RDTX), PT Jaya Real Property Tbk (JRPT), PT Jaya Sukses Makmur Sentosa Tbk (RISE). The cyclical consumer sector consists of PT MNC Digital Entertainment Tbk (MSIN), PT MD Entertainment Tbk (FILM), PT Fortune Indonesia Tbk (FORU), PT Jakarta Setiabudi International Tbk (JSPT), PT Multistrada Arah Sarana Tbk (MASA), PT Mitra Pinasthika Mustika Tbk (MPMX), PT Arthavest Tbk (ARTA).

The selection of seven stocks from each industry is based on ease of calculation and diversification efficiency. This decision refers to research by Evans & Archer (1968) which shows that the reduction in risk from adding more than ten stocks is not proportional to the potential additional costs. The time and effort sacrificed by investors to analyze, evaluate, and track the performance of stocks in the portfolio are additional costs. Another study by Tarrazo (2024) found that small portfolios consisting of five to six stocks are more efficient to manage.

Value at Risk (VaR) and Conditional Value at Risk (CVaR) are used to calculate estimated risk, in addition to using standard deviation in this study. The non-parametric method used is historical simulation. In accordance with Fama's (1965) statement, the Mean Variance framework traditionally uses variance as a measure of risk associated with the assumption of normally distributed returns. This assumption is often inconsistent with empirical market conditions, as indicated by the long-tailed distribution of returns. Historical simulation is considered more effective for describing actual portfolio risk without relying on specific distribution assumptions and is easier to implement.

4. Results and Discussion

A separate analysis of the portfolio shows a trade-off between risk and return that varies across sectors. The Mean Variance model combined with the Python programming language produces an output in the form of an Excel file containing tables that present the weight allocation composition of each stock along with its return and risk. In this discussion, we will describe the results of the calculations for each sector and the combination of the three sectors, followed by an explanation of the efficient frontier consisting of four curves, each curve representing four portfolios (health sector, property sector, cyclical consumer sector, and a combination of the three sectors).

Each curve has a starting point on the left end and an end point on the right end, which determine its length. At the beginning, on the left end, the Minimum Variance Portfolio (MVP) is the combination of stocks in the group with the lowest possible risk. The right end point is the maximum expected return portfolio, which is fully allocated to one or more individual stocks with the highest expected returns among all stocks in the group.

Portfolio performance is measured using risk metrics beyond return and volatility (standard deviation). The Coefficient of Variation (CV) calculates relative risk per unit of return. This allows for the comparison of portfolios with different return levels. With this, Value at Risk (VaR) determines the minimum potential loss, which is 5% at a 95% confidence level, and Conditional Value at Risk (CVaR) determines the minimum potential loss by calculating the average loss if the worst-case scenario exceeds VaR.

The results of the Mean Variance model calculations in this study do not present a single superior portfolio but rather an efficient portfolio that serves as a decision framework to provide strategies for investors by combining various investment options. Two investment options, namely maximum expected return and minimum variance, each have their own consequences: the higher the expected return, the higher the variance. Thus, investors can choose according to their preferences. Risk-averse investors prioritize risk minimization, while risk-tolerant investors prioritize maximizing expected returns.

Healthcare Sector

HEALTHCARE	Maximum Expected Return																			Minimum Variance
	Weight																			
SILO	0,00%	0,44%	0,88%	1,31%	1,75%	2,19%	2,63%	3,06%	3,50%	3,94%	4,38%	4,82%	5,25%	5,69%	6,13%	6,57%	7,00%	7,44%	7,88%	8,32%
SRAJ	100,00%	94,93%	89,86%	84,80%	79,73%	74,66%	69,59%	64,53%	59,46%	54,39%	49,32%	44,25%	39,19%	34,12%	29,05%	23,98%	18,92%	13,85%	8,78%	3,71%
TSPC	0,00%	1,41%	2,81%	4,22%	5,63%	7,03%	8,44%	9,85%	11,25%	12,66%	14,06%	15,47%	16,88%	18,28%	19,69%	21,10%	22,50%	23,91%	25,32%	26,72%
PYFA	0,00%	0,07%	0,14%	0,21%	0,28%	0,35%	0,42%	0,49%	0,56%	0,63%	0,70%	0,77%	0,84%	0,91%	0,98%	1,05%	1,13%	1,20%	1,27%	1,34%
SAME	0,00%	0,35%	0,70%	1,05%	1,40%	1,76%	2,11%	2,46%	2,81%	3,16%	3,51%	3,86%	4,21%	4,57%	4,92%	5,27%	5,62%	5,97%	6,32%	6,67%
MERK	0,00%	1,65%	3,30%	4,95%	6,60%	8,25%	9,90%	11,55%	13,20%	14,85%	16,50%	18,15%	19,80%	21,45%	23,10%	24,75%	26,40%	28,05%	29,70%	31,35%
HEAL	0,00%	1,15%	2,30%	3,46%	4,61%	5,76%	6,91%	8,06%	9,21%	10,37%	11,52%	12,67%	13,82%	14,97%	16,13%	17,28%	18,43%	19,58%	20,73%	21,89%
Expected Return	0,209%	0,202%	0,195%	0,188%	0,182%	0,175%	0,168%	0,161%	0,154%	0,147%	0,140%	0,133%	0,127%	0,120%	0,113%	0,106%	0,099%	0,092%	0,085%	0,078%
Standard Deviation	0,047	0,045	0,043	0,040	0,038	0,036	0,033	0,031	0,029	0,027	0,024	0,022	0,020	0,018	0,016	0,015	0,013	0,012	0,011	0,011
Coefficient of Variation (CV)	22,652	22,258	21,839	21,396	20,924	20,423	19,890	19,323	18,722	18,084	17,410	16,704	15,972	15,228	14,498	13,827	13,292	13,016	13,174	13,990
Value at Risk (VaR)	-6,64%	-6,34%	-6,01%	-5,65%	-5,30%	-4,96%	-4,59%	-4,20%	-3,84%	-3,57%	-3,25%	-2,92%	-2,60%	-2,34%	-2,12%	-1,94%	-1,73%	-1,57%	-1,50%	-1,40%
Conditional Value at Risk (CVaR)	-8,24%	-7,81%	-7,40%	-6,99%	-6,58%	-6,19%	-5,80%	-5,41%	-5,03%	-4,66%	-4,29%	-3,94%	-3,61%	-3,28%	-2,97%	-2,70%	-2,49%	-2,36%	-2,29%	-2,29%

Figure 2. Optimal Composition of Healthcare Sector Stocks

Source: Yahoo Finance, processed by the author, 2025

The figure above shows the weight composition of the Mean Variance model calculation for the healthcare sector. For risk-tolerant investors, 100% of the funds are allocated to PT Siloam International Hospitals Tbk (SILO) shares. For risk-averse investors, the majority of the fund is invested in shares of PT Merck Tbk (MERK) with a weight of 31.35%, PT Tempo Scan Pacific Tbk (TSPC) at 26.72%, and PT Medikaloka Hermina Tbk (HEAL) at 21.89%. The maximum expected return portfolio yields a return of 0.209% and a risk of 0.047. The minimum variance portfolio yields a return of 0.078% and a risk of 0.011. From the calculation results table, an efficient frontier visualization is created.

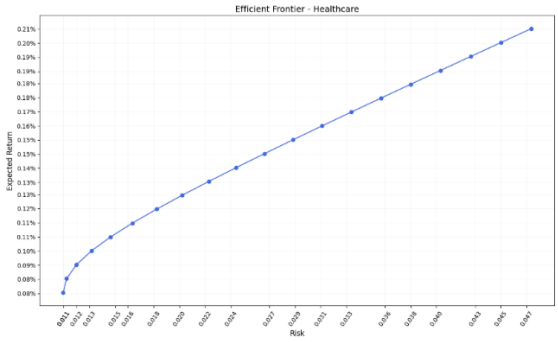

Figure 3. Efficient Frontier of the Health Sector
Source: Yahoo Finance, processed by the author, 2025

The coefficient of variation (CV) for the minimum variance portfolio is 13.990, while the maximum expected return portfolio has a CV of 22.652. In a more in-depth risk analysis of the minimum variance portfolio, we find that the CVaR is -2.29% in unstable market conditions. If the market is in a normal condition, the VaR in this sector is -1.40%. This data provides an overview of downside risk that is not only captured by standard deviation.

Property Sector

The property sector, on the other hand, presents a much higher risk profile than the healthcare sector, but with higher expected returns. The expected return is 0.626% with a risk of 0.054, while at minimum variance, the risk is 0.009 and the return is 0.093%.

PROPERTY	Maximum Expected Return																		Minimum Variance
	Weight																		
PANI	100,00%	94,86%	89,72%	84,58%	79,44%	74,30%	69,16%	64,02%	58,88%	53,74%	48,60%	43,46%	38,32%	33,18%	28,04%	22,90%	17,76%	12,62%	7,48%	2,34%
SMDM	0,00%	0,22%	0,45%	0,67%	0,89%	1,11%	1,34%	1,56%	1,78%	2,01%	2,23%	2,45%	2,67%	2,90%	3,12%	3,34%	3,57%	3,79%	4,01%	4,23%
LPLI	0,00%	0,22%	0,44%	0,66%	0,89%	1,11%	1,33%	1,55%	1,77%	1,99%	2,21%	2,43%	2,66%	2,88%	3,10%	3,32%	3,54%	3,76%	3,98%	4,21%
SATU	0,00%	0,39%	0,77%	1,16%	1,55%	1,94%	2,32%	2,71%	3,10%	3,48%	3,87%	4,26%	4,64%	5,03%	5,42%	5,81%	6,19%	6,58%	6,97%	7,35%
RDTX	0,00%	0,54%	1,08%	1,62%	2,16%	2,70%	3,24%	3,78%	4,32%	4,86%	5,40%	5,94%	6,48%	7,02%	7,56%	8,10%	8,64%	9,18%	9,72%	10,26%
JRPT	0,00%	2,36%	4,72%	7,08%	9,44%	11,80%	14,16%	16,52%	18,88%	21,24%	23,60%	25,96%	28,31%	30,67%	33,03%	35,39%	37,75%	40,11%	42,47%	44,83%
RISE	0,00%	1,41%	2,82%	4,23%	5,64%	7,05%	8,45%	9,86%	11,27%	12,68%	14,09%	15,50%	16,91%	18,32%	19,73%	21,14%	22,55%	23,96%	25,36%	26,77%
Expected Return	0,626%	0,598%	0,570%	0,542%	0,514%	0,486%	0,458%	0,430%	0,402%	0,374%	0,346%	0,318%	0,290%	0,262%	0,233%	0,205%	0,177%	0,149%	0,121%	0,093%
Standard Deviation	0,054	0,051	0,048	0,045	0,043	0,040	0,037	0,035	0,032	0,029	0,027	0,024	0,021	0,019	0,017	0,014	0,012	0,011	0,009	0,009
Coefficient of Variation (CV)	8,5452	8,4891	8,4282	8,3620	8,2900	8,2112	8,1249	8,0301	7,9257	7,8109	7,6845	7,5462	7,3966	7,2391	7,0829	6,9511	6,8985	7,0537	7,7158	9,5691
Value at Risk (VaR)	-6,98%	-6,61%	-6,24%	-5,87%	-5,50%	-5,14%	-4,78%	-4,42%	-4,10%	-3,77%	-3,43%	-3,10%	-2,77%	-2,42%	-2,16%	-1,88%	-1,59%	-1,40%	-1,25%	-1,21%
Conditional Value at Risk (CVaR)	-7,95%	-7,54%	-7,13%	-6,74%	-6,35%	-5,96%	-5,58%	-5,21%	-4,84%	-4,47%	-4,11%	-3,75%	-3,40%	-3,06%	-2,74%	-2,45%	-2,19%	-2,00%	-1,88%	-1,86%

Figure 4. Optimal Composition of Property Sector Stocks
Source: Yahoo Finance, processed by the author, 2025

When investing in the property sector, to get the maximum expected return for risk-tolerant investors, it is necessary to allocate 100% of funds to PT Pantai Indah Kapuk Dua Tbk (PANI) shares. If investors wish to minimize risk, funds should be allocated across three stocks: PT Jaya Real Property Tbk (JRPT) at 44.83%, PT Jaya Sukses Makmur Sentosa Tbk (RISE) at 26.77%, and PT Roda Vivatex Tbk (RDTX) at 10.26%.

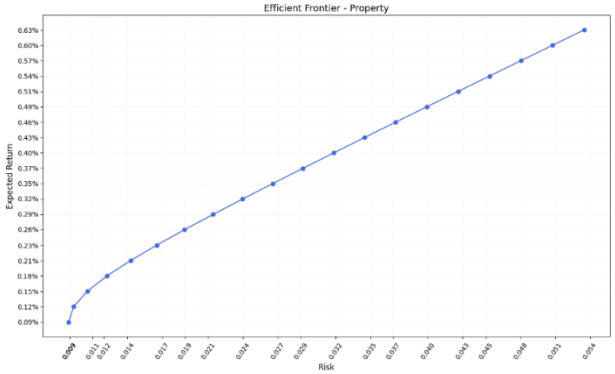

Figure 5. Efficient Frontier of the Property Sector
Source: Yahoo Finance, processed by the author, 2025

The CV value in the property sector is lower than in the healthcare sector, both in the minimum variance portfolio and the maximum expected return portfolio, at 8.5452 and 9.5691, respectively. In the minimum variance portfolio under normal conditions, the VaR of the property sector portfolio generates a potential daily loss of -1.21%, and when the market is outside normal conditions, the CVaR level is -1.86%. The CVaR of the real estate sector in the maximum expected return portfolio, which is -7.95%, shows a slight increase from the CVaR of the healthcare sector (-8.24%), meaning it still has a significantly higher expected return than the healthcare sector. The risk of the healthcare sector remains disproportionate to the returns it generates.

Cyclical Consumer Sector

Cyclical consumers have different risk and return characteristics between the healthcare and property sectors, where no weight is entirely in one sector. In this sector, investors seeking to maximize returns have three stock options for capital allocation, PT Fortune Indonesia Tbk (FORU) at 24.17%, PT MD Entertainment Tbk (FILM) at 23.88%, and PT MNC Digital Entertainment Tbk (MSIN) at 22.39%.

CONSUMER CYCLICAL	Maximum Expected Return																		Minimum Variance
	Weight																		
MSIN	22,39%	21,71%	21,03%	20,35%	19,66%	18,98%	18,30%	17,62%	16,94%	16,26%	15,58%	14,89%	14,21%	13,53%	12,85%	12,17%	11,49%	10,81%	10,12%	9,44%
FILM	23,88%	22,97%	22,05%	21,13%	20,22%	19,30%	18,39%	17,47%	16,56%	15,64%	14,73%	13,81%	12,89%	11,98%	11,06%	10,15%	9,23%	8,32%	7,40%	6,48%
FORU	24,17%	23,20%	22,23%	21,27%	20,30%	19,33%	18,36%	17,39%	16,42%	15,46%	14,49%	13,52%	12,55%	11,58%	10,62%	9,65%	8,68%	7,71%	6,74%	5,77%
JSPT	14,63%	14,62%	14,62%	14,61%	14,61%	14,60%	14,59%	14,59%	14,58%	14,57%	14,57%	14,56%	14,55%	14,55%	14,54%	14,54%	14,53%	14,52%	14,52%	14,51%
MASA	14,93%	14,70%	14,48%	14,26%	14,04%	13,81%	13,59%	13,37%	13,15%	12,92%	12,70%	12,48%	12,26%	12,04%	11,81%	11,59%	11,37%	11,15%	10,92%	10,70%
MPMX	0,00%	2,00%	3,99%	5,99%	7,98%	9,98%	11,97%	13,97%	15,97%	17,96%	19,96%	21,95%	23,95%	25,94%	27,94%	29,94%	31,93%	33,93%	35,92%	37,92%
ARTA	0,00%	0,80%	1,60%	2,40%	3,19%	3,99%	4,79%	5,59%	6,39%	7,19%	7,98%	8,78%	9,58%	10,38%	11,18%	11,98%	12,77%	13,57%	14,37%	15,17%
Expected Return	0,245%	0,240%	0,236%	0,232%	0,228%	0,224%	0,220%	0,216%	0,212%	0,208%	0,203%	0,199%	0,195%	0,191%	0,187%	0,183%	0,179%	0,175%	0,171%	0,166%
Standard Deviation	0,023	0,022	0,021	0,021	0,020	0,020	0,019	0,018	0,018	0,017	0,017	0,016	0,016	0,016	0,015	0,015	0,015	0,015	0,015	0,015
Coefficient of Variation (CV)	9,3268	9,1996	9,0751	8,9541	8,8375	8,7266	8,6226	8,5270	8,4414	8,3678	8,3081	8,2649	8,2407	8,2382	8,2604	8,3105	8,3918	8,5077	8,6616	8,8568
Value at Risk (VaR)	-2,93%	-2,86%	-2,78%	-2,70%	-2,62%	-2,57%	-2,51%	-2,47%	-2,46%	-2,40%	-2,34%	-2,29%	-2,26%	-2,23%	-2,17%	-2,16%	-2,16%	-2,15%	-2,15%	-2,13%
Conditional Value at Risk (CVaR)	-3,98%	-3,88%	-3,78%	-3,68%	-3,60%	-3,51%	-3,44%	-3,37%	-3,30%	-3,23%	-3,16%	-3,10%	-3,04%	-2,99%	-2,94%	-2,91%	-2,88%	-2,85%	-2,84%	-2,84%

Figure 6. Optimal Composition of Cyclical Consumer Sector Stocks
Source: Yahoo Finance, processed by the author, 2025

For risk-averse investors, the weight allocation is concentrated on three companies, namely PT Mitra Pinasthika Mustika Tbk (MPMX) at 37.29%, PT Arthavest Tbk (ARTA) at 15.17%, and interestingly, PT Jakarta Setiabudi International Tbk (JSPT) delivers the maximum expected return with balanced minimum risk, namely 14.63% and 14.51%. The maximum expected return portfolio for this sector offers a return of 0.245% and a risk of 0.023.

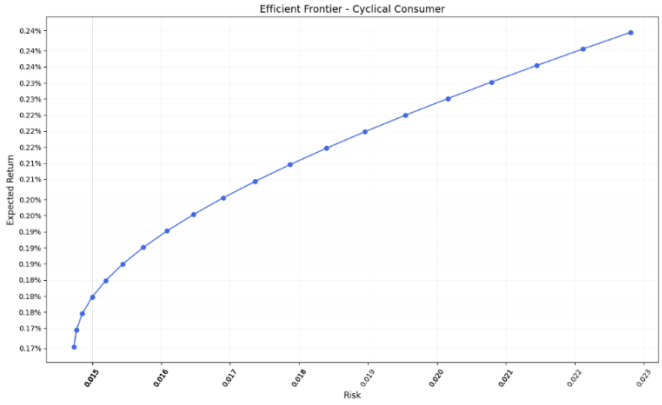

Figure 7. Efficient Boundaries of the Cyclical Consumer Sector
Source: Yahoo Finance, processed by the author, 2025

This portfolio records a CV of 8.8568 in the minimum variance portfolio, which indicates a slightly better risk-return efficiency than the property sector. With a VaR of -2.13% and a CVaR of -2.84% in the minimum variance portfolio, this portfolio highlights the potential for significantly greater average losses than the property sector in the event of a adverse market scenario. Although the return generated is high at 0.166%, the standard deviation of 0.015 is also the highest among real estate and healthcare. Risk-averse investors should carefully consider this CVaR.

Combination of Three Sectors

The advantages of cross-sector diversification are demonstrated in portfolios that combine all three sectors. Significantly, the minimum variance portfolio of the combined three sectors achieved the lowest absolute risk level, at 0.007. In the combined portfolio, PT Pantai Indah Kapuk Dua Tbk (PANI) shares dominate with a weight of 100%. For investors targeting maximum expected returns, all funds are allocated to these shares. For minimum risk, there are two stock choices: PT Jaya Real Property Tbk (JRPT) and PT Jaya Sukses Makmur Sentosa Tbk (RISE), with respective weights of 21.55% and 16.88%.

In line with Modern Portfolio Theory (MPT), a portfolio combining all three sectors can optimize risk and return profiles. This figure is even lower than the risk level of the property sector, which is 0.009, the safest sector individually. This demonstrates that combining stocks from different sectors can mitigate volatility more effectively than investing solely in a single safe sector.

COMBINATION	Maximum Expected Return																			Minimum Variance
	Weight																			
SILO	0,00%	0,14%	0,27%	0,41%	0,54%	0,68%	0,81%	0,95%	1,09%	1,22%	1,36%	1,49%	1,63%	1,76%	1,90%	2,03%	2,17%	2,31%	2,44%	2,58%
SRAJ	0,00%	0,10%	0,20%	0,30%	0,40%	0,50%	0,60%	0,70%	0,81%	0,91%	1,01%	1,11%	1,21%	1,31%	1,41%	1,51%	1,61%	1,71%	1,81%	1,91%
TSPC	0,00%	0,41%	0,82%	1,23%	1,64%	2,05%	2,45%	2,86%	3,27%	3,68%	4,09%	4,50%	4,91%	5,32%	5,73%	6,14%	6,54%	6,95%	7,36%	7,77%
PYFA	0,00%	0,02%	0,05%	0,07%	0,10%	0,12%	0,15%	0,17%	0,20%	0,22%	0,25%	0,27%	0,30%	0,32%	0,35%	0,37%	0,40%	0,42%	0,45%	0,47%
SAME	0,00%	0,08%	0,16%	0,24%	0,32%	0,40%	0,48%	0,56%	0,64%	0,73%	0,81%	0,89%	0,97%	1,05%	1,13%	1,21%	1,29%	1,37%	1,45%	1,53%
MERK	0,00%	0,48%	0,96%	1,44%	1,92%	2,40%	2,88%	3,36%	3,84%	4,32%	4,80%	5,28%	5,76%	6,24%	6,72%	7,21%	7,69%	8,17%	8,65%	9,13%
HEAL	0,00%	0,38%	0,76%	1,14%	1,52%	1,90%	2,28%	2,66%	3,04%	3,41%	3,79%	4,17%	4,55%	4,93%	5,31%	5,69%	6,07%	6,45%	6,83%	7,21%
PANI	100,00%	94,80%	89,61%	84,41%	79,22%	74,02%	68,83%	63,63%	58,44%	53,24%	48,05%	42,85%	37,65%	32,46%	27,26%	22,07%	16,87%	11,68%	6,48%	1,29%
SMDM	0,00%	0,11%	0,21%	0,32%	0,43%	0,54%	0,64%	0,75%	0,86%	0,96%	1,07%	1,18%	1,29%	1,39%	1,50%	1,61%	1,71%	1,82%	1,93%	2,04%
LPLI	0,00%	0,14%	0,28%	0,42%	0,56%	0,70%	0,84%	0,98%	1,12%	1,26%	1,40%	1,54%	1,68%	1,82%	1,96%	2,10%	2,24%	2,38%	2,52%	2,66%
SATU	0,00%	0,23%	0,46%	0,70%	0,93%	1,16%	1,39%	1,62%	1,86%	2,09%	2,32%	2,55%	2,78%	3,02%	3,25%	3,48%	3,71%	3,94%	4,18%	4,41%
RDTX	0,00%	0,32%	0,63%	0,95%	1,26%	1,58%	1,89%	2,21%	2,52%	2,84%	3,15%	3,47%	3,78%	4,10%	4,41%	4,73%	5,04%	5,36%	5,67%	5,99%
JRPT	0,00%	1,13%	2,27%	3,40%	4,54%	5,67%	6,81%	7,94%	9,08%	10,21%	11,34%	12,48%	13,61%	14,75%	15,88%	17,02%	18,15%	19,28%	20,42%	21,55%
RISE	0,00%	0,89%	1,78%	2,66%	3,55%	4,44%	5,33%	6,22%	7,11%	7,99%	8,88%	9,77%	10,66%	11,55%	12,43%	13,32%	14,21%	15,10%	15,99%	16,88%
MSIN	0,00%	0,13%	0,26%	0,39%	0,53%	0,66%	0,79%	0,92%	1,05%	1,18%	1,31%	1,44%	1,58%	1,71%	1,84%	1,97%	2,10%	2,23%	2,36%	2,50%
FILM	0,00%	0,01%	0,01%	0,02%	0,02%	0,03%	0,04%	0,04%	0,05%	0,06%	0,06%	0,07%	0,07%	0,08%	0,09%	0,09%	0,10%	0,11%	0,11%	0,12%
FORU	0,00%	0,04%	0,08%	0,12%	0,16%	0,20%	0,24%	0,28%	0,32%	0,36%	0,40%	0,44%	0,48%	0,52%	0,56%	0,60%	0,64%	0,68%	0,72%	0,76%
JSPT	0,00%	0,16%	0,31%	0,47%	0,63%	0,78%	0,94%	1,10%	1,25%	1,41%	1,57%	1,72%	1,88%	2,03%	2,19%	2,35%	2,50%	2,66%	2,82%	2,97%
MASA	0,00%	0,15%	0,29%	0,44%	0,59%	0,74%	0,88%	1,03%	1,18%	1,32%	1,47%	1,62%	1,76%	1,91%	2,06%	2,21%	2,35%	2,50%	2,65%	2,79%
MPMX	0,00%	0,13%	0,26%	0,39%	0,52%	0,65%	0,78%	0,91%	1,04%	1,17%	1,30%	1,43%	1,56%	1,70%	1,83%	1,96%	2,09%	2,22%	2,35%	2,48%
ARTA	0,00%	0,16%	0,31%	0,47%	0,63%	0,78%	0,94%	1,10%	1,25%	1,41%	1,57%	1,72%	1,88%	2,04%	2,19%	2,35%	2,50%	2,66%	2,82%	2,97%
Expected Return	0,626%	0,599%	0,571%	0,544%	0,516%	0,489%	0,461%	0,434%	0,406%	0,379%	0,351%	0,324%	0,296%	0,269%	0,241%	0,214%	0,186%	0,159%	0,131%	0,104%
Standard Deviation	0,054	0,051	0,048	0,045	0,042	0,040	0,037	0,034	0,032	0,029	0,026	0,023	0,021	0,018	0,016	0,013	0,011	0,009	0,008	0,007
Coefficient of Variation (CV)	8,5452	8,4758	8,4002	8,3177	8,2272	8,1276	8,0176	7,8954	7,7592	7,6066	7,4349	7,2411	7,0221	6,7751	6,5000	6,2041	5,9164	5,7245	5,8698	6,9328
Value at Risk (VaR)	-6,98%	-6,59%	-6,23%	-5,85%	-5,49%	-5,11%	-4,74%	-4,39%	-4,04%	-3,69%	-3,35%	-3,00%	-2,65%	-2,30%	-2,01%	-1,70%	-1,46%	-1,22%	-1,08%	-0,99%
Conditional Value at Risk (CVaR)	-7,95%	-7,54%	-7,13%	-6,72%	-6,32%	-5,92%	-5,52%	-5,14%	-4,75%	-4,38%	-4,00%	-3,64%	-3,28%	-2,92%	-2,57%	-2,25%	-1,95%	-1,70%	-1,51%	-1,44%

Figure 8. Optimal Composition of the Three Sectors
Source: Yahoo Finance, processed by the author, 2025

With a Coefficient of Variation (CV) of 6.9328, the combined portfolio has the most superior risk-return efficiency. The benefits of diversification are most evident when analyzing extreme loss risk, with the CVaR of the minimum variance portfolio showing a figure of -1.44%, which exceeds the CVaR of the three sectors. This proves that cross-sector diversification can mitigate potential losses in the worst-case market scenario and effectively improve portfolio efficiency.

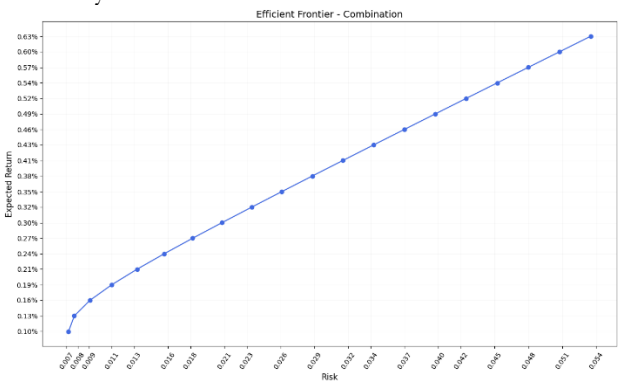

Figure 9. Efficient Frontier of Combined Portfolios
Source: Yahoo Finance, processed by the author, 2025

Figure 9 presents a visualization of the efficient frontier curves for each of the four types of portfolios analyzed: sectoral portfolios (healthcare, property, and cyclical consumer goods) and a combined portfolio. From this visualization, we can see the positions of the curves representing each sector and the combined portfolio, while comparing which curve is the most efficient according to investor preferences.

The relationship between risk, measured by standard deviation on the X-axis, and expected return on the Y-axis is depicted in this graph. Each curve in this graph represents a series of optimal portfolios, with each point on the curve offering the highest return for a given level of risk. The different risk-return characteristics and profiles of each investment group are visually represented by the position and shape of the curve.

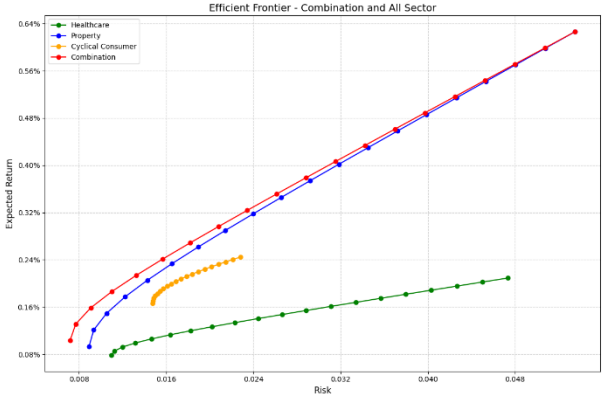

Figure 10. Efficient Frontier of Combined Portfolios and Three Sectors
Source: Yahoo Finance, processed by the author, 2025

For the combined portfolio (red), which combines all three sectors, it is above the individual sector curves and in the upper left position compared to the property and healthcare curves. The combined portfolio offers lower risk for each desired level of return, whereas for each acceptable level of risk, the combined portfolio offers a higher return. This demonstrates that cross-sector diversification can reduce risk, as combining stocks with imperfect correlation can enhance portfolio efficiency. For example, the combined portfolio offers a return of 0.24% at a risk level of around 0.016, while the cyclical consumer portfolio (orange) only offers the same return at a higher risk level of 0.023.

The healthcare sector (green) is at the bottom, with the point on the left side of the curve indicating the lowest risk level among the three sector curves and the combined curve. Additionally, the maximum expected return for this sector is also the lowest among the other two sectors. The healthcare sector is the least efficient, as it offers the lowest expected return for each level of risk taken.

The cyclical consumer sector (orange) actually provides a higher return at the left end point of around 0.016% with the same risk as the healthcare sector. The rightmost point also provides a higher return of 0.24% with lower risk compared to the right end point of the healthcare sector. Investors seeking to minimize risk while maximizing returns should invest in a portfolio with the highest expected return in the cyclical consumer sector. Similarly, the left tail also offers high expected returns but with the same level of risk.

The right-hand curve of the property sector (blue) provides the highest maximum return accompanied by the highest risk among the cyclical consumer and healthcare sectors. The slightly higher left-hand end point offers an advantage in expected returns of 0.009% with lower risk compared to the healthcare sector at around 0.011. Risk-averse investors interested in investing their funds in a sectoral portfolio are recommended to invest in the left-hand tail of the property sector curve.

The proximity of the combined curve (red) and the property curve (blue) indicates that the property sector has a dominant influence on the combined portfolio. This is because the property sector has the highest expected return at 0.626%, three times that of the healthcare and cyclical consumer sectors, accompanied by high risk at 0.054. There is a crucial difference highlighting the benefits of diversification. An investor can achieve a return of 0.32% with a combined portfolio at a risk level of approximately 0.023. If investing solely in the real estate sector, the risk is slightly higher at 0.024. Additionally, at the left end of the combined curve, it offers a return of around 0.10% with a risk of 0.007%, compared to the real estate sector's risk of 0.009%.

Cross-Sector Risk Measurement Comparison

The use of alternative risk measures other than standard deviation, which is based solely on volatility, such as Coefficient of Variation (CV), Value at Risk (VaR) and Conditional Value at Risk (CVaR), provides a more in-depth picture of the likelihood of future risks. Investors can obtain additional references in developing investment strategies by comparing risk measures across sectors and combined portfolios. Risk measures from the Minimum Variance Portfolio (MVP) are used in this comparison, as minimum variance represents the lowest possible risk level that can be achieved. By comparing these safest points, we can directly measure the effectiveness of diversification in reducing risk.

Metric	Healthcare	Property	Cyclical Consumer	Combination
Expected Return	0,078%	0,093%	0,166%	0,104%
Standard Deviation	0,011	0,009	0,015	0,007
Coefficient of Variation (CV)	13,990	9,5691	8,8568	6,9328
Value at Risk (VaR)	-1,40%	-1,21%	-2,13%	-0,99%
Conditional Value at Risk (CVaR)	-2,29%	-1,86%	-2,84%	-1,44%

Figure 11. Comparison of Risk Sizes
Source: Processed from Tables 2, 3, 4, and 5

The table shows that the combined portfolio achieved the lowest absolute standard deviation, 0.007, well below the property sector's standard deviation of 0.009. When comparing the Coefficient of Variation (CV), the advantage of diversification becomes even clearer, with the combined portfolio having the lowest CV of 6.9328, which is lower than all three sectors. By comparing risk measures, it can be seen that the combined portfolio is better

at mitigating extreme risk, as evidenced by the Conditional Value at Risk (CVaR) measure of -1.44%, which is significantly better than the CVaR of the property sector (-1.86%), healthcare (-2.29%), and cyclical consumer (-2.84%). This means that investors can reduce overall volatility by diversifying across sectors. They can also significantly reduce their potential losses in the worst market scenarios. The returns generated are also better than those of the healthcare and property sectors, although still below the cyclical consumer sector, but the risk taken is far below that of the three sectors.

This study does not use data from the maximum return portfolio because the main focus of this study is different. In the combined portfolio, the highest return is dominated by one property stock, namely PT Pantai Indah Kapuk Dua Tbk (PANI). If we compare these points, it will only emphasize the performance of the best-performing stock rather than evaluating the benefits of combining stocks, and the resulting risk is also very high. By focusing on the minimum variance portfolio, it can clearly show how combining uncorrelated stocks can produce a new portfolio with lower risk than the risk of each component, which is an important part of diversification.

Analysis of Performance Differences Between Sectors

Fiscal incentives, particularly the government-funded PPN DTP program for the 2021–2022 period, effectively reduced purchase costs and stimulated housing demand, thereby accelerating the recovery of the property sector (Kementerian Keuangan, 2022). This was reinforced by Bank Indonesia's decision to create a favorable lending environment by maintaining the benchmark interest rate (BI7DRR) at 3.50% for most of 2021 (Office of Chief Economist Bank Mandiri, 2021). During the recovery phase, the return on assets (ROA) of property companies increased significantly as a result of these combined factors (Aji & Haptari, 2022).

The BI 7-Day Reverse Repo Rate (BI7DRR), inflation, and export rates also had a positive impact on the stock prices of the cyclical consumer sector (Anggrainy & Nugroho, 2024). During the pandemic, the profitability, solvency, and activity ratios of the cyclical consumer sector declined significantly (Kristanto & Yanto, 2022). Improvements began to appear in the 2021-2023 period, with cyclical consumer industries such as media and entertainment showing improved financial performance compared to 2020 (Tjhin et al., 2024). A Bank Indonesia (BI) survey showed a change in the proportion of household income allocation, with income for consumption increasing compared to income for savings (Tempo.co, 2025). On the other hand, BPS (Central Statistics Agency) shows a decline in the middle class to the vulnerable middle class or poor in 2024 (Rachman, 2024). This has led to a decline in the growth of companies in the cyclical consumer sector during this period.

Unlike the property sector, which was driven by policy stimulus, the health sector was driven by the COVID-19 pandemic. Hospital operators experienced increased profits due to high demand for COVID-19-related services, such as treatment and hospitalization (Iswara, 2021). In line with the success of the vaccination program, there was a normalization phase in demand for COVID-19-related services and income. The financial performance of issuers in the healthcare sector after the lifting of the Enforcement of Restrictions on Community Activities (*Pemberlakuan Pembatasan Kegiatan Masyarakat* or PPKM) in 2023 was less stable than during the COVID-19 pandemic (Badoa & Kumenap, 2023).

Implications of Cross-Sector Diversification

According to Jumrahma et al. (2022), the effectiveness of diversification depends not only on the number of stocks in the portfolio, but also on how the movements of these stocks interact with each other, with correlation values ranging from -1 to +1. The lower the correlation between stocks, the greater the likelihood that risk will be reduced, but this does not eliminate the overall risk of the portfolio. Systematic risk, also known as market risk or beta, is a risk that cannot be completely avoided and can only be eliminated through proper diversification (Aniswati et al., 2024)

Proper diversification does not depend on quantity, but on quality. Having a portfolio consisting of, for example, ten different banking stocks tends to have a very high correlation between them, leading to increased risk. Conversely, a portfolio consisting of seven stocks from three different sectors, such as in this study, namely property, healthcare, and cyclical consumer goods, is an example of much better diversification, even though the number of stocks is smaller. This is because potential losses on one stock are offset by gains on another. The key is to find a combination of stocks with different business drivers, which will result in low correlation.

5. Conclusion

The Mean Variance model provides quantitative analysis that can complement technical and fundamental analysis. The use of the Python programming language in mathematical calculations, automation, and large-scale data processing facilitates the implementation of the model. The analysis results provide key findings regarding the effectiveness of cross-sector diversification, as demonstrated by combining the three sectors into a single portfolio. The performance of the combined portfolio exceeds that of the single-sector portfolios. With the lowest standard deviation of 0.007, the smallest CV of 6.9328, a VaR of -0.99%, and the lowest CVaR of -1.44%, it still provides a return of 0.104%. This shows that cross-sector diversification is more effective than investing in a single sector in reducing volatility and minimizing the potential for extreme losses. The efficient frontier graph can serve as an information map regarding the trade-off between return and risk for investors according to their investment preferences. Ultimately, this study not only confirms the validity of Modern Portfolio Theory (MPT) but also provides strategic implications for investors.

This study has several limitations. First, the time range is limited to 2020 to 2025. Second, the analysis only focuses on three sectors. Third, the assumption of normally distributed returns in the Mean Variance model means that the standard deviation used as a measure of risk does not fully capture market reality. Fifth, the calculation of VaR and CVaR only uses the non-parametric historical simulation method. Practical problems also arise when the Mean Variance model is applied in real stock exchange trading. (Setiawan & Rosadi, 2019) state that this model cannot help investors limit stock weights and the number of shares, does not take transaction costs into account, and cannot produce weights in lot units.

Suggestions for further research include adding other time periods and sectors, as well as using semi-parametric methods that allow for better risk mitigation, such as Extreme Value Theory (EVT), Filtered Historical Simulation (FHS), and Conditional autoregressive Value at Risk (CaViaR) (Abad et al., 2013). In accordance with the statement by Setiawan & Rosadi (2019), modifying the Mean Variance model by adding heuristic methods such as genetic algorithms, simulated annealing, Tabu search, particle algorithms, and bee colony algorithms can also be a solution to the practicality problems of this model and can be an interesting topic for further research.

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